

to have them established as a foundation from which to start.

The problem of free vibrations is first treated, and as an example the propagation of plane waves of (i.) normal, (ii.) tangential, displacement is investigated. It is a pity that the author has not here taken the opportunity of illustrating some previous remarks on the discontinuity of the forms of the strain and stress components which necessarily accompanies a change in the nature of the medium, by considering the question of the reflection and refraction of plane waves.

The general form of the solution of the equations for forced vibrations is next investigated. Then follows the general question of equilibrium. As a simple example the case of a cylindrical tube under external and internal normal pressures is first treated. It is almost annoying to find the solution of this time-honoured question obtained by starting from the general equations, and whittling them down till the very simple conditions are fulfilled. The equilibrium of a solid sphere, with either surface tractions or displacements given, is treated exactly as in Thomson and Tait's work. The chapter of general solutions closes with an account of Airy's general method for plain stress, with a couple of examples. The printing was unfortunately so far advanced that this had to be left; though before the book appeared the author had himself shown, in a communication to the London Mathematical Society, that these examples of Airy's are faulty, and that the method applies only to a very limited class of cases.

Chapter VII. consists mainly of a capital exposition of the solution of St. Venant's problems of the torsion and flexure of prisms. These problems are probably, from a practical point of view, the most important for which an exact solution has been obtained. The author brings out well the bearings of the nature of the solutions on practical questions of construction. The elastic equilibrium and small motions of wires, whether straight or curved, are deduced directly from the results of St. Venant's problems. In connection with this part of the subject, certain interesting questions of stability, due to Mr. Greenhill, are discussed.

Some cases of the equilibrium and vibrations of plates and shells are considered in Chapter VIII. For the equilibrium of a plate of uniform thickness under a system of surface tractions parallel to its faces and acting on its edges, a solution is obtained by analysis very similar to that used in St. Venant's problem. The case of a thin plate under the action of applied faces satisfying certain conditions is quoted from Thomson and Tait again.

Two short chapters headed "Impact" and "Viscosity" complete the volume. The former consists of the solution of two problems, one of which, as the author implies, has nothing to do with impulsive change of motion. Indeed, as is well known, the exact treatment of the impact of elastic bodies involves difficulties, even in comparatively simple cases, which have not yet been overcome. In the last chapter the alteration in the form of the dynamical equations is determined, which results from supposing the shearing stress to vary partly as the shear and partly as its rate of change.

Having thus given some account of the plan of the

book and the way in which it has been carried out generally, we may offer some remarks on matters of detail. It may be said at once that as regards accuracy there is a good deal to be desired. The table of errata might have been tripled, and would not then have contained all the misprints. In §§ 299, 306, the wholesale omission of signs of summation in the equations makes the analysis, as given, incorrect; and there is little doubt but that anyone to whom the matter treated was new would be completely baffled. The inaccuracies, moreover, are not confined to mere misprints. There are one or two positive mistakes in the mathematics. Thus at the bottom of p. 58 it is implied that some condition is necessary in order that a family of surfaces, $f(x, y, z) = \xi$ (an arbitrary parameter), may have a system of continuous curves cutting them at right angles; and in a note at the foot of p. 298 it is stated that, supposing this (entirely imaginary) condition satisfied, two other systems of surfaces can always be found cutting each other and the former surfaces everywhere at right angles. Now the three parameters of such a triple system of surfaces have to satisfy three independent partial differential equations, and hence no one of the three can be taken arbitrarily. Statements and reasoning are, in several passages, founded on this erroneous conception. Closely allied with this is the construction given in § 216 for tubes of stress. It is here practically assumed that a given continuous system of curves can always be cut at right angles by a family of continuous surfaces.

An appendix at the end of Chapter II., on "The Geometry of Strains," might have been omitted with advantage. It has no very obvious connection with the preceding chapter, but is devoted to an apparently new classification of vector quantities, in which a velocity and a force are the types of the one group, while an angular and a couple are those of the other! Again, in §§ 270, 271, the solution of a physical problem is made to appear to depend on the choice of an origin. The question treated is the free normal vibrations of a plate; and, after using d and $-d'$ to denote the abscissæ of the two faces, and making the result appear to depend on d/d' , the question is *simplified* by taking the origin midway between the faces. Indeed, frequently throughout the book one is reminded of Clerk Maxwell's remark on "the state of a mind conscious of knowing the absolute position of a point."

These slips, such as they are, and an occasional obscurity of language, are but slight blemishes on a valuable book. A friendly but independent criticism of the proof-sheets while the book was passing through the press might have removed them all, and no doubt will in a new edition.

The figures throughout are excellent.

THE VOLCANIC AND CORAL ISLANDS OF THE SOLOMON GROUP.

The Solomon Islands: their Geology, General Features, and Suitability for Colonization. By H. B. Guppy, M.B., F.G.S., late Surgeon R.N. (London: Swan Sonnenschein, Lowrey, and Co., 1887.)

SURGEONS in Her Majesty's navy are favoured beyond most men in the possession of abundant leisure and freedom from many of the common cares of

life. But in spite of the frequent changes of scene which they enjoy, or endure, and their unique opportunities for pursuing scientific researches, and in spite of their early acquaintance with elementary treatises on several branches of science, it is only at rare intervals that naval surgeons appear as observers or investigators. The unusual occasionally happens, and in the work by Mr. Guppy on the Solomon Islands we have an admirable example of what may be accomplished by an energetic observer alive to his advantages.

In this volume it would not be difficult to point out many imperfect forms of expression, some avoidable confusion in arrangement, even a few conclusions that the facts hardly appear to warrant; but these sink into insignificance when compared with the mass of valuable material from which they might be culled.

The object of the book is to describe fully, but in a general way, the author's geological observations on the islands of the Solomon Group, little space being devoted to the other subjects mentioned in the title. It is a compendium of important facts, most of them new to the scientific public. Perhaps the Journal of the Geological Society is hardly suited for recording a series of laborious and detailed observations on the rocks of a remote archipelago, and the publications of the Royal Society of Edinburgh—where detailed papers by Mr. Guppy appear—may not be read by all geologists. It may not be inappropriate, in these circumstances, to mention a few of the facts observed by Mr. Guppy and recorded in this volume.

The book is divided equally between the description of volcanic and calcareous islands, and is illustrated by maps and sections.

The volcanic rocks collected on the islands were submitted for mineralogical analysis to Prof. Judd and Mr. T. Davies; the calcareous formations were studied by Mr. John Murray; and the remains of animal life, both foraminiferal and coral, are being examined by the leading specialists; hence the work is enriched by the labours of well-known men, and the "gold" of the author's data impressed with the "guinea-stamp" of recognized authority.

The volcanic islands of the group are divided into two classes. First, those of comparatively modern formation, composed mainly of little-altered augite-andesites, andesitic pitchstones, tuffs, and agglomerates: these islands still preserve the volcanic outline and sometimes give evidence of recent activity by terminating in craters with hot springs or fumaroles. The second class is composed only in part of these rocks, and in part of much more ancient crystalline masses consisting chiefly of altered dolerites, quartz-diorites and -porphyries, and serpentines. Some islands of the latter class exhibit an extraordinary diversity in petrological character. Fauno, the description of which is illustrated by a geological map, is an interesting instance of this. The northern end of the island is occupied by a precipitous mountain of andesitic tuff sloping steeply down from an altitude of 1900 feet to a narrow isthmus, 150 feet high, composed of hornblende-augite-andesite, and leading to a sickle-shaped peninsula of successive hills connected by low strips of rock. The composition of this crescentic tongue is successively altered dolerites, quartz-porphyries, quartz-andesites, hornblende-andesites, and altered dolerites

again. These rocks, almost invariably massive and unassociated with tuffs or agglomerates, each in turn occupy the whole breadth of the peninsula. The mode of formation which Mr. Guppy demonstrates for this promontory is illustrated in various stages by several other islands. A series of small volcanoes arising in a crescentic form, and each pouring out a characteristic lava, were gradually elevated and so brought into connection. Rapid denudation, caused by the great rainfall of the region, wore off the volcanic contours and reduced the chain of peaks to a series of "necks" in close juxtaposition. The comparative rarity of fragmental volcanic rocks, and the mineralogical constitution of the massive crystalline lavas of the surface, indicating their solidification at great depths, prove extensive denudation to have taken place all over those islands.

The main interest of the book centres in the researches of Mr. Guppy on calcareous deposits. He is the only geologist who has visited this most instructive group of coral islands; and he describes what he saw there with a straightforward simplicity that compels confidence in the accuracy of his observations, and affords to those who may find his theory insufficient all possible data for disproving it.

Mr. Guppy gives the following classification of the limestones of a "coral island" in the Solomon Group as revealed to him by the walls of the river gorges he explored:—

Group I.—*Coral Limestones*, properly so called.

Group II.—*Coral Limestones* which have the composition of coral muds or sands now forming near coral reefs. There are three subdivisions of this group: (1) crystalline limestone, in which coral plays a secondary part, and remains of calcareous Algæ and mollusks predominate; (2) chalky limestones; (3) homogeneous fawn-coloured limestones, often crystalline.

Group III.—*Rocks of the composition of volcanic mud and pteropod ooze*, containing also numerous Foraminifera. These are subdivided into (1) partially consolidated volcanic muds; (2) partially consolidated pteropod ooze; (3) hard limestones.

Group IV.—*Foraminiferal Limestones*, or consolidated "Globigerina ooze." There are two classes: (1) composed chiefly of tests of both pelagic and bottom-living Foraminifera; (2) chiefly composed of the tests of pelagic Foraminifera.

Group V.—*Rock resembling a consolidated deep-sea clay (Red Clay)*.

The two last-named groups were certainly deposited at depths not much less than 2000 fathoms in an ocean far from continental land, and their existence above sea-level is now for the first time proved.

From all the facts that could be ascertained regarding the coral formations of the group, certain inferences were drawn, which we give in the author's own words:—

"The first is self-evident, viz. *that these upraised reef masses, whether atoll, barrier reef, or fringing reef, were formed in a region of elevation*. . . . It is apparent that Mr. Darwin's theory of coral reefs, which ascribes atoll and barrier reefs to a movement of subsidence, cannot be applied to the islands of the Solomon Group. . . .

"The second inference is, *that such upraised reefs are of moderate thickness, their vertical measurement not exceeding the usual limit of the depth of the reef-coral zone*.

... I never found one that exhibited a greater thickness of coral limestone than 150 feet, or at the very outside 200 feet. . . .

"The third inference is, that these upraised reef masses in the majority of islands rest on a partially consolidated deposit which possesses the characters of the 'volcanic muds' that were found, during the 'Challenger' Expedition, to be at present forming around volcanic islands.

"The fourth inference is, that this deposit envelops anciently submerged volcanic peaks."

Mr. Guppy states that his observations have made him a strong adherent of the theory of formation of coral islands advanced by Mr. Murray.

These observations are indeed crucial between the theories of subsidence and of solution, and point towards the newer. The theory of subsidence demands that a coral reef rising from deep water must be of enormous thickness, and rest upon volcanic or fragmental rock; that of solution requires that the reef be of slight thickness and rest on volcanic rock, or consolidated terrigenous mud, or pelagic ooze. According to the former the reef grows on the whole vertically; according to the latter its main extension is horizontal. Two of Darwin's principal objections to the early conception of coral islands were that it was absurd to suppose that submarine mountains were numerous enough to provide foundations for all the known reefs, and that it was impossible to imagine sedimentation taking place at great distances from land. The recent work of telegraph ships along the West Coast of Africa and elsewhere has shown the extreme probability of submarine mountains existing in large numbers throughout the ocean; the cruise of the *Challenger* proved that the shells of pelagic organisms, wind-borne and meteoric dust and volcanic ashes spread by ocean-currents produce perceptible sedimentation in mid-ocean at a rate varying in some inverse proportion to the depth.

Murray's theory can be brought readily to the test of observation and experiment; Darwin's cannot. It has been shown in the laboratory that calcium carbonate is soluble in sea-water, and is dissolved in greater amount in water containing carbonic acid especially when under pressure; the decomposition of dead corals and the respiration of living ones supply carbonic acid to aid in the removal of their calcareous remains. If atolls are formed in areas of elevation, they may ultimately be seen and measured: if only in regions of subsidence, measurement is impossible, and the vertical extent of the coral limestone can only be guessed at.

It must be confessed that the theory of solution in reef-building has not yet been put before the world with any approach to the completeness, lucidity, and grace with which Darwin convinced and enchained the scientific mind. The theory of subsidence is so beautiful, simple, and satisfactory, that very strong evidence is required to shake it; but in the history of science men have more than once been forced to say of a simple and satisfactory doctrine—

" 'Twas beautiful,
Yet but a dream, and so—Adieu to it! "

Neither Murray nor Guppy has proved the subsidence theory to be a dream. Still, the solution theory has been plainly set forth, and here we have facts which amount to an absolute proof of its truth for one important group of

coral islands. The proof is none the less convincing because it is restricted in its application; for it is concrete and complete in itself, not abstract and cumulative like the evidence for the subsidence theory. Mr. Guppy has demonstrated that the old theory fails and the new succeeds in explaining the formation and structure of the Solomon Islands, and coming at the present time this supplies a powerful argument for the general applicability of the solution theory—an argument that it will not be easy to set aside.

The book is short and interesting; and, besides the important features we have alluded to, it contains much information about the islands visited, and the author's adventures there.

HUGH ROBERT MILL.

AGRICULTURE IN SOME OF ITS RELATIONS WITH CHEMISTRY.

Agriculture in some of its Relations with Chemistry.

By F. H. Storer. Two Vols. (London: Sampson Low, Marston, Searle, and Rivington, 1887.)

THIS work, by the Professor of Agricultural Chemistry at the Harvard University, is based on a course of lectures delivered annually by the author. It is addressed to students of agriculture and persons fond of rural affairs, rather than to students of chemistry. Free use has been made of German publications in agricultural chemistry, and of the writings of Prof. S. W. Johnson, of Newhaven, Connecticut. Some of the matters treated of in his two well-known books, "How Crops Grow" and "How Crops Feed," have been omitted, or only lightly touched, in the present volumes, which are therefore, to a certain extent, a supplement to those books.

The present volumes treat of the chemistry of the atmosphere, of waters, of soils, and of manures, and of their several relations to plants; the chemistry of animal life and nutrition is not dealt with. A large amount of valuable information, partly of historical interest, has been brought together; and much of it is presented in the somewhat old-fashioned English of the best writers of New England.

One illustration given by the author, to show that liquids penetrate into plants through their roots, we do not think very happy. He notes an observation made by himself, that Indian corn made to sprout in a flower-pot and watered with milk had white leaves; and he suggests that the minute particles of solid matter in the milk must have entered the plant and caused the whiteness. He admits, however, that the whiteness may have been due to chemical action. In noticing the growth of plants in artificial light, he hardly gives sufficient credit to the observations of Siemens and of Dehérain on growth in the light of the electric arc, both uncovered and variously shaded. Mr. Storer has scarcely that respect for earth-worms with which Darwin has imbued us, for on the only occasion he mentions them he styles them pernicious, on the ground that harm is done to plants in pots by their casts, which become slimy mud when watered, and thus clog the pores of the earth and the roots of the plants.

In vol. i. p. 295, a serious mistake occurs, though